Metallofluorocarbon Nanoemulsion for Inflammatory Macrophage Detection via PET and MRI.

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Public Summary:
Inflammation is associated with a range of serious human conditions including autoimmune and cardiovascular diseases and cancer. The ability to image active inflammatory processes greatly enhances our ability to diagnose and treat these diseases at an early stage. We describe molecular compositions enabling sensitive and precise imaging of inflammatory hotspots in vivo.

Scientific Abstract:
Inflammation is associated with a range of serious human conditions, including autoimmune and cardiovascular diseases and cancer. The ability to image active inflammatory processes greatly enhances our ability to diagnose and treat these diseases at an early stage. We describe molecular compositions enabling sensitive and precise imaging of inflammatory hotspots in vivo. Methods: A functionalized nanoemulsion with a fluorocarbon-encapsulated radiometal chelate (FERM) was developed to serve as a platform for multimodal imaging probe development. The (19)F-containing FERM nanoemulsion encapsulates (89)Zr in the fluorous oil via a fluorinated hydroxamic acid chelate. Simple mixing of the radiometal with the preformed aqueous nanoemulsion before use yields FERM, a stable in vivo cell tracer, enabling whole-body (89)Zr PET and (19)F MRI after a single intravenous injection. Results: The FERM nanoemulsion was intrinsically taken up by phagocytic immune cells, particularly macrophages, with high specificity. FERM stability was demonstrated by a high correlation between the (19)F and (89)Zr content in the blood (correlation coefficient > 0.99). Image sensitivity at a low dose (37 kBq) was observed in a rodent model of acute infection. The versatility of FERM was further demonstrated in models of inflammatory bowel disease and 4T1 tumor. Conclusion: Multimodal detection using FERM yields robust whole-body lesion detection and leverages the strengths of combined PET and (19)F MRI. The FERM nanoemulsion has scalable production and is potentially useful for precise diagnosis, stratification, and treatment monitoring of inflammatory diseases.